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Phonon self-energy corrections to non-zero wavevector phonon modes in single-layer graphene PAULO ARAUJO, Massachusetts Institute of Technology, DANIELA MAFRA, Universidade Federal de Minas Gerais, KENTARO SATO, RICHIIRO SAITO, Tohoku University, JING KONG, MILDRED DRESSELHAUS, Massachusetts Institute of Technology — Phonon self-energy corrections have mostly been studied theoretically and experimentally for phonon modes with zone-center (q= 0) wave-vectors. Here, gate-modulated Raman scattering is used to study phonons of a single layer of graphene (1LG) in the frequency range from 2350 to 2750 cm^{-1}, which shows the G* and the G'-band features originating from a double-resonant Raman process with $q \neq 0$. The observed phonon renormalization effects are different from what is observed for the zone-center q= 0 case. To explain our experimental findings, we explored the phonon self-energy for the phonons with non-zero wave-vectors ($q \neq$ 0) in 1LG in which the frequencies and decay widths are expected to behave oppositely to the behavior observed in the corresponding zone-center q= 0 processes. Within this framework, we resolve the identification of the phonon modes contributing to the G* Raman feature at 2450 cm^{-1} to include the iTO+LA combination modes with $q \neq 0$ and the 2iTO overtone modes with q= 0, showing both to be associated with wave-vectors near the high symmetry point **K** in the Brillouin zone.

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